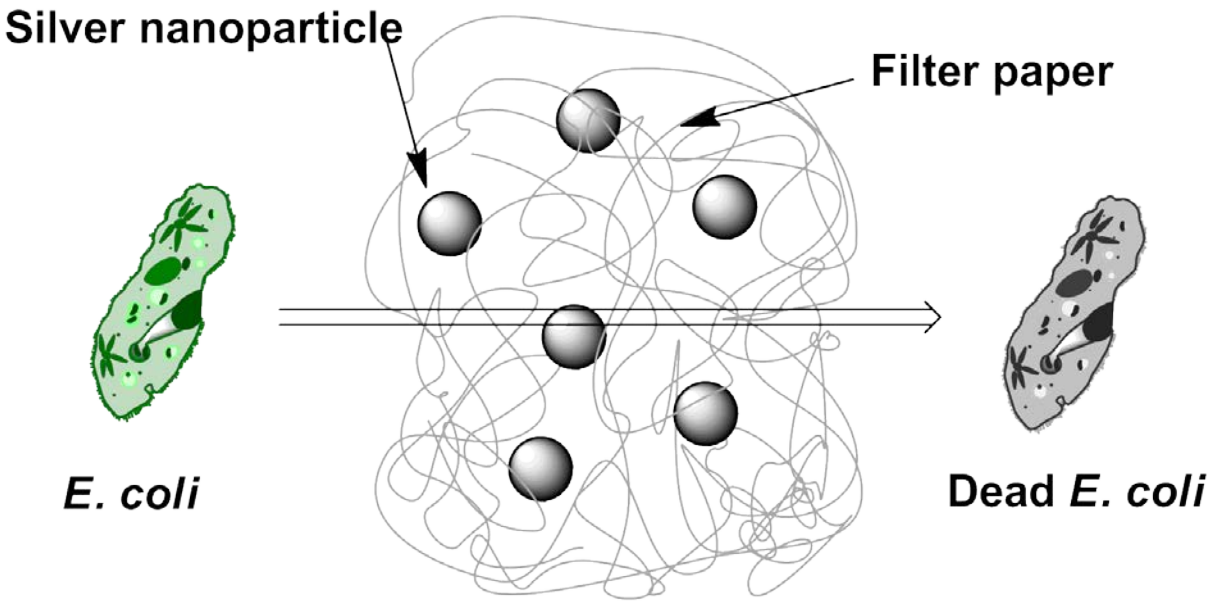
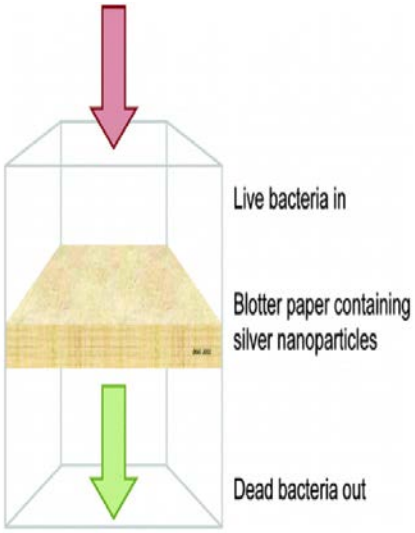
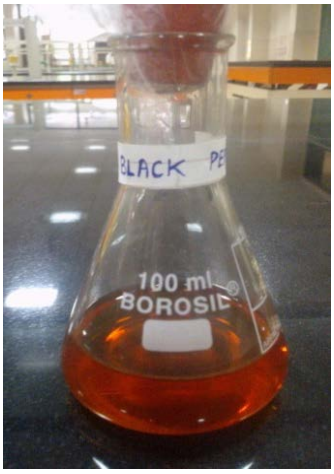
Innovation Project 2015-2016

MH-306: Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles







University of Delhi

Certificate of Originality

This is to certify that the research work carried out and the final report submitted By the Project Investigators and the students of Innovation Project having Project code **MH-306** and title **Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles** of College/ Institute **Miranda House** is original. Any plagiarism/academic dishonesty reported at any stage will be our responsibility.

Signatures of the all PIs

Dr. Mallika Pathak
Assistant Professor
Department of Chemistry
Miranda House
University of Delhi

Dr. Malti Sharma
Assistant Professor
Department of Chemistry
Miranda House
University of Delhi

Dr. Rekha Kumari
Assistant Professor
Department of Zoology
Miranda House
University of Delhi

Utilization Certificate

Innovation Project MH – 306 (2015-16)

Project Title: Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles

Audited Financial Statement under Innovation Project scheme

College: Miranda House

Project Investigators: Dr Mallika Pathak, Dr Malti Sharma, Dr Rekha Kumari

Grant Sanctioned		(In figures) Rs 6,00,000/- (In Words) Six Lakh rupees only			
S. No.	Budget Head	Amount Sanctioned	Amount Utilised	Balance	
	Equipments/Consumables	3,25,000	3,25,000	Nil	
	Travel	55,000	55,000	Nil	
	Stipend	1,20,000	1,20,000	Nil	
	Honorarium	25,000	25,000	Nil	
	Stationery	20,000	19,344	656	
	Contingency	55,000	55,000	Nil	
	Total amount utilized Rs. (In figures and words)	5,99,344/- (Five Lakh Ninety Nine Thousand Three hundred and forty four rupees only)			
	Amount remaining Rs. (In figures and words)	656/- (Six Hundred Fifty Six only)			

Certified that out of Rs. 600000/- (Six Lakh only) sanctioned to Innovation Project Code MH-306, Rs 5,99,344/- (Five Lakh Ninety Nine Thousand Three hundred and Forty Four rupees only) has been utilized during the period of the project. The remaining amount 656/- (Six Hundred Fifty Six only) is being returned back to the University.

Signature of Project Investigators

Dr Mallika Pathak

Dr Malti Sharma

Dr Rekha Kumari

Signature of Principal
Principal
Miranda House

Gupta Nandan & Associates
New Delhi
M. No. 086537
Chartered Accountants

Financial Audit Clearance and Stamp of Chartered Accountant

UNVERSITY OF DELHI

INNOVATION PROJECTS 2015-16

FINAL REPORT

1. PROJECT CODE: **MH-306**

2. PROJECT TITLE: **Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles**

3. NAME OF COLLEGE/INSTITUTION: **Miranda House**

4. PRINCIPAL INVESTIGATORS (NAME, DEPARTMENT, EMAIL, PHONE NO.)

- **Dr. Mallika Pathak**
  Assistant Professor, Department of Chemistry
  mallika.pathak@mirandahouse.ac.in
  mobile: +91-9810754091

- **Dr. Malti Sharma**
  Assistant Professor, Department of Chemistry
  malti.sharma@mirandahouse.ac.in
  mobile: +91-9811881447

- **Dr. Rekha Kumari**
  Assistant Professor. Department of Zoology
  rekha.kumari@mirandahouse.ac.in
  mobile: +91-9582347742

5. MENTOR

Prof. Sitharaman Uma
Department of chemistry
University of Delhi Delhi 110 007
suma@chemistry.du.ac.in
mobile: 09818123170

6. STUDENTS INVOLVED IN THE PROJECT (NAME, DEPARTMENT, EMAIL ID AND PHONE NUMBER)

S. No	**Name**	**Department**	**Email ID**	**Phone no.**
1	Raksha Jain	B.Sc.(H) Chemistry III year	raksha2896@gmail.com	9971407826
2	Mahima Rajput	B.Sc .(H) Chemistry III year	mahimarajput70@gmail.com	9718388236
3	Ayushi Pandey	B.Sc .(H) Chemistry III year	ayushi94500@gmail.com	7042327481
4	Ipshita Majumdar	B.Sc. (H) Chemistry III year	ipshitamajumdar@rediffmail.com	8527002736
5	Divya Bhatt	B.Sc. (H) Chemistry III year	divyabhatt021@gmail.com	8373941786
6	Harsha Maheshwari	B.Sc .(H) Chemistry III year	destination.harsha@gmail.com	9971290158
7	Payal	B.Sc .(H) Zoology III Year	payalnashier@gmail.com	8053639338
8	Aishwarya Khare	B.Sc.(H) Zoology III year	aishkhare.khare@gmail.com	9717122184
9	Sunidhi	B.Sc.(H) Zoology III year	sunidhi771@gmail.com	9643727686
10	Komal	B.Sc.(H) Zoology III year	komal3266@gmail.com	9871751626

PROJECT TITLE: Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles

PROJECT CODE: MH-306

ABSTRACT:

There is a pressing need for small-scale, simple and affordable point-of-use purification systems that can purify water of bacteria and other harmful microorganisms. As part of the project we have designed the following water purification prototypes using green silver nanoparticles (AgNP) that can provide clean water, meet the international safety standard and help in combating drinking water crisis in emergency situation.

1. Silver Earthen pot
2. Silver Sachet
3. Silver Dialysis tube

The silver nanoparticles used in the above prototypes have been synthesized in good yield and relative good stability through green method using plant extracts. The aim is to inactivate bacteria when sachet or dialysis tube is dipped in water or when water is kept in the earthen pot. The AgNP containing purification devices were tested for antimicrobial activity and silver leaching. They exhibited antimicrobial properties towards *E. coli* and *S. aureus*. The silver loss from the purification devices was minimal. These devices can be used as an effective emergency water treatment to provide safe drinking water to millions of people especially in natural disasters and other emergencies.

These prototypes have other merits over and above the above mentioned ones such as easy availability of starting materials, inexpensive process, simple reaction conditions, avoidance of use of hazardous and toxic reagents and pollution free environment. Water purification devices made using green AgNP can provide clean water within 1 hr without using electricity or heating or any harmful rays. Silver nanoparticles were chosen for water purification because of their good antibacterial activity.

INTRODUCTION:

According to the World Health Organization, over one billion people do not have access to clean drinking water. In countries such as India, 80% of the diseases such as cholera or gastroenteritis are due to bacterial contamination of drinking water. Removal of microorganisms from drinking water to obtain potable water is a critical requirement in various societies across the world, and particularly in India. Today a number of techniques are used for treatment of water such as chlorine and it's derivatives, Ultraviolet light, Low frequency ultrasonic irradiation, Distillation, Reverse Osmosis, Water sediment filters (fiber and ceramic), Ozonisation etc. Halogens such as chlorine (Cl) and bromine (Br) are well known as antibacterial agents, but the direct use of

halogens as bactericides has many problems because of their high toxicity and vapor pressure in pure form.

There is a pressing need for small-scale filter systems that can purify water of bacteria and other harmful microorganisms. A simple and inexpensive filtering system could provide safe drinking water for millions of people who are in short supply of clean water, especially in rural areas, natural disasters and other emergencies. These filtering devices must be cheap, safe, portable and easy to use.

OBJECTIVES:

The overall research objective is to study the synthesis, characterization of AgNP and its antimicrobial property and build a water purification device thereby obtaining pathogen-free water over a sustained period of time, without any loss of activity of AgNP.

Project had the following four developmental components

- Green Synthesis of AgNP using spice (cinnamon, fennel, clove, cumin and black pepper) extracts
- Characterization of synthesized AgNP (UV-Vis spectra, TEM, Zeta Potential etc)
- Antimicrobial analysis of synthesized AgNP.
- Develop purification devices using green AgNP that can provides 10 liters of clean water in about an hour time and also meets the international safety standards
- Study the antimicrobial activity of water before and after purification using the designed purification devices.

METHODOLOGY:

- Green Synthesis of AgNP in bulk using water as a solvent
- Characterization of green AgNP.
- Antibacterial analysis of green AgNP.
- Developed small-scale, simple and affordable point-of-use purification devices using green AgNP.
- Studied the antimicrobial activity of water before and after purification using the designed purification devices.

RESULT AND DISCUSSION:

Synthesis of Silver Nanoparticles (AgNP) and their characterization

AgNP were prepared by reducing silver nitrate with spice extracts of clove, cinnamon, cumin, black pepper and fennel seeds using Green Method. The biomolecules contained in these plant materials not only played a role in reducing the silver particles to the nanosize, but also played an important role in the capping of nanoparticles. It was observed that the Green Synthesis yielded AgNP in good amount with relative good stability. The synthesised AgNP were characterized by colour change, UV-Vis spectrophotometry, Tyndall effect, Transmission Electron Microscopy and zeta potentiometry. The spectra exhibit a Surface Plasmon Resonance (SPR) absorption band in the range of 416-431 nm confirming the size to be around 30 nm. The position of band did not change after one week, depicting the stability of prepared NP, although absorbance showed a red shift with decrease in the absorbance value. Further, the antibacterial activity analysis showed that the bacterial samples (*S. aureus and E. coli*) treated with the synthesized silver nanoparticles showed minimum inhibitory concentration in the range of 25-30 µM.

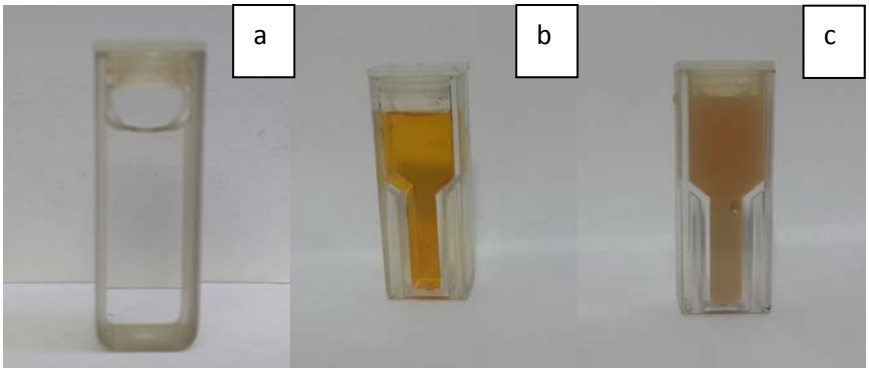


Fig 1: (a) $AgNO_3$ solution and AgNP prepared (b) using clove (b) using cinnamon

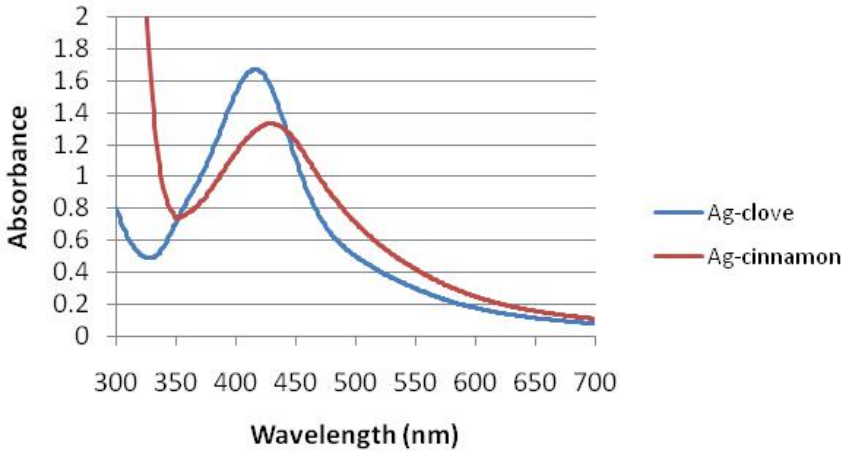


Fig 2: UV-Vis Spectrum: Plasmon Resonance of AgNP synthesized using clove and cinnamon

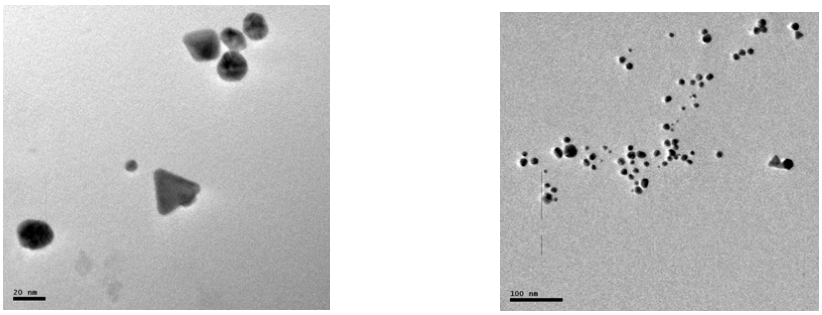


Fig 3: TEM images of AgNP prepared

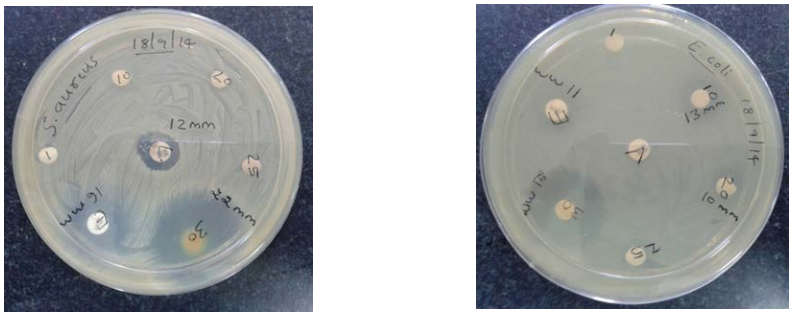


Fig 4: Antimicrobial activity of AgNPs against (a) *S. Aureus* (b) *E. Coli*

Point-of- Use Purification devices

AgNP made by using cinnamon as reducing and stabilizing agent were then used for making purification devices. Two of the purification devices developed are in the form of sachet and dialysis tube containing green and eco-friendly AgNP embedded in starch based bioplastic and the other is in the form of a earthen pot soaked with the same AgNP. The aim is to inactivate bacteria when sachet or dialysis tube is dipped in water or when water is kept in the earthen pot. We then investigated the antimicrobial activity of AgNP on water with and without AgNP-sachet or dialysis tube and on water kept in earthen pot soaked with and without AgNP. They exhibited antimicrobial properties towards *E. coli* and *S. aureus*. These devices can be used as an effective emergency water treatment to provide safe drinking water to millions of people especially in natural disasters and other emergencies.

1. **Silver earthen pot for water purification**

Fig 5: Silver Earthen Pot for Water Purification

Adopted two methodologies for testing the Viability of microbial cells after their treatment with Nanoparticles.

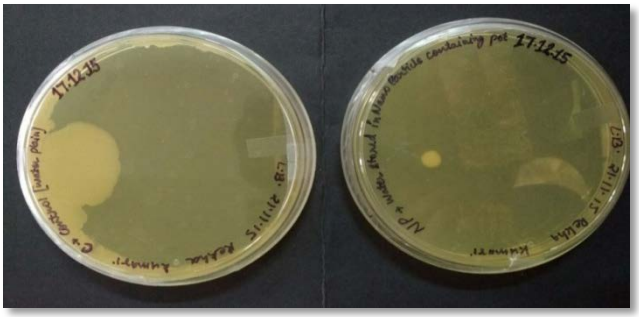
Aliquot plating: To check activity of nanoparticles on water kept for 10 minutes in earthen pots soaked overnight with and without nanoparticles

A (CONTROL)	**B (Experimental)**
Soaked Earthen pot A in Distilled water overnight.	Soaked the Earthen pot B in Nanoparticles (NP) solution prepared from cinnamon overnight
Emptied the earthen pots into different falcons.	
Kept tap water (20 mL) in earthen pot A & B for 10 minutes	
Took LB (Luria Bertani) agar plate and spread an aliquot of 200µL from each earthen pot.	
Kept the plates in incubator at 37°C overnight.	

- In Aliquot plating, we observed that the control plate showed much more bacterial growth as compared to the test plate.
- In Whole sample plating method, we have observed that the control plates showed bacterial growth while the test plates did not show any growth.

Methodology/Experimental Measures adopted	**Aliquot Plating**	**Whole sample Plating**
Time of Action Tested	10 minutes	20 hours
Quantity Plated	150µL	Pallet suspended in 100µL MQ water(made out of 20mL water)

	Control	Test	Control	Test
	Showed greater bacterial growth	Lesser bacterial growth	Showed bacterial growth	No bacterial growth



Control Plate Water kept in earthen pot A is plated	Test Plate Water kept in earthen pot B which is soaked in NP is plated

Fig 6: Aliquot Plating of Water kept in Earthen Pot

Whole Plating Method

1. We concluded that the second method (whole plating method) showed more significant results where activity of nanoparticles was actually tested and certified because there was no growth on the plates.
2. Hence, we can say that nanoparticles showed bacterial reduction when timing of action was increased to 20 hrs.
3. Testing with greater concentrations (as in whole plating method [20mL] showed more significant results as compared to aliquot method where we tested with a concentration of 200 µL.

2. Silver Sachet for water purification

Silver sachet is prepared by dipping silica gel in AgNP solution for overnight followed by drying. This AgNP embedded silica gel is then packed in a muslin cloth.

Fig 7: Silver Sachet

	Control plate	Test plate
Procedure	Took water sample to be tested.	Silver sachet dipped for 4 hours in water sample to be tested.
	Centrifuged 5mL of above water samples separately, and dissolved the respective pellets in 200µL MQ water and used them for plating by spread plate method.	
Observation	Bacterial growth was observed.	No bacterial growth was observed.
Inference	Bacterial growth occurred as there was no nanoparticle treatment.	Antimicrobial activity of nanoparticles is justified since no bacterial growth.

Fig 8: Control plate (bacterial growth)

Fig 9: Test plate (no bacterial growth)

3. Silver Dialysis Tube for Water Purification

Fig 10: Silver Dialysis tube

Silver Dialysis tube was made by putting AgNP-starch based bioplastic gel in dialysis membrane and tying both the end (Fig. 10). This was then used as water purification device by dipping it in water for half an hour.

	Control plate	**Test plate**
Procedure	Took water sample to be tested.	Silver Dialysis Tube dipped for half an hours in water sample to be tested.
	Centrifuged 5mL of above water samples separately, and dissolved the respective pellets in 200µL MQ water and used them for plating by spread plate method.	
Observation	Bacterial growth was observed.	No bacterial growth was observed.
Inference	Bacterial growth occurred as there was no nanoparticle treatment.	More efficient antimicrobial activity of nanoparticles is justified since no bacterial growth.

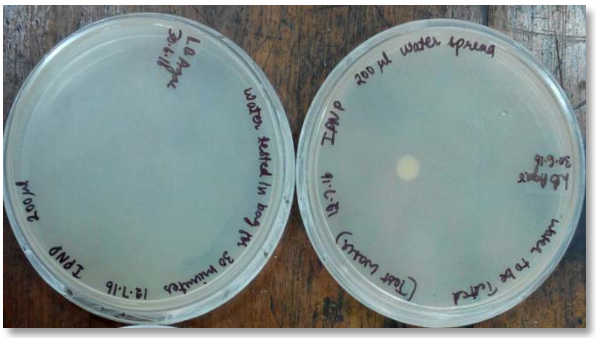


Fig 11: Test plate (no bacterial growth) & Control plate (bacterial growth)

- The AgNP-starch based bioplastic obtained show antimicrobial activity in both sachet and dialysing tube.
- Dialyzing membrane has an additional advantage that the gel does not leach out into water.

INNOVATIONS SHOWN BY THE PROJECT

1. **Silver earthen pot for water purification**
2. **Silver Sachet for water purification**
3. **Silver Dialysis tube for water purification**

CONCLUSION AND FUTURE DIRECTION

- The bioplastic pellet obtained show antimicrobial activity in both muslin cloth and dialysing membrane.
- Dialyzing membrane has an additional advantage that the gel does not leach out into water.

REFERENCES

1. Kim, J.S., Kuk, E., Yu, K.N., Kim, J.H., Park ,S.J., Lee, H.J., Kim, S.H., Park, Y.K.,Park, Y.H.,Hwang, C.Y.,Kim, Y.K.,Lee, Y.S.,Jeong, D.H.&Cho, M.H. (2007). Antimicrobial effects of silver nanoparticles. *Nanomedicine*. 3, 95-101.
2. Morones, J. R., Elechiguerra, J. L., Camacho, A., Holt, K., Kouri, J. B., Ramírez, J. T.&Yacaman, M. J. (2005). The bactericidal effect of silver nanoparticles. *Nanotechnology.* 16(10), 2346-2353.
3. Willner, I., Baron, R.&Willner, B. (2006). Growing metal nanoparticles by enzymes. *J. Adv. Mater.* 18, 1109-1120.
4. Konishi, Y.&Uruga, T. (2007). Bioreductive deposition of platinum nanoparticles on the bacterium *Shewanella algae*. *J. Biotechnol.* 128, 648-653.
5. Bankar, A., Joshi, B., Kumar A. R. & Zinjarde, S. (2010). Banana peel extract mediated novel route for the synthesis of silver nanoparticles. *Colloids and Surfaces A: Physicochemical and Engineering Aspects,* 368(1–3), 58–63.
6. Bauer, A. W., Perry,D. M. &Kirby,W. M. M.(1959).Single disc antibiotic sensitivity testing of Staphylococci.A.M.A. *Arch. Intern. Med.*104, 208–216.
7. Bauer, A. W., Kirby, W. M. M. , Sherris, J. C. & Turck, M.(1966). Antibiotic susceptibility testing by a standardized single disk method. *Am. J. Clin.Pathol*.36, 493-496.
8. Usha Rani, P. & Rajasekharreddy, P. (2011). Green synthesis of silver-protein (core-shell) nanoparticles using Piper betle L. leaf extract and its ecotoxicological studies on Daphnia magna. *Colloids and Surfaces A: Physicochemical and Engineering Aspects.* 389 (1–3), 188–194.
9. Saeb, Amr T. M., Alshammari, *Ahmad* S., Al-Brahim, Hessa. & Al-Rubeaan, Khalid A. (2014). Production of Silver Nanoparticles with Strong and Stable Antimicrobial Activity against Highly Pathogenic and Multidrug Resistant Bacteria. *The Scientific World Journal* Article ID 704708, 9 pages.
10. Kelly, K. L., Coronado, E., Zhao, L. L. &Schatz, G. C. (2003). The optical properties of metal nanoparticles: the influence of size, shape, and dielectric environment. *J. Phys. Chem. B.* 107(3), 668–677.
11. Cecilia, N.(2007) Surface Plasmons on Metal Nanoparticles: The Influence of Shape and Physical Environment *J. Phys. Chem. C.* 111(10), 3806–3819.

12. Banerjee, P., Satapathy, M., Mukhopahayay, A.& Das, P. (2014). Leaf extract mediated green synthesis of silver nanoparticles from widely available Indian plants: synthesis, characterization, antimicrobial property and toxicity analysis. *Bioresour Bioprocessing.* 1(3), 1-10.

13. Shahverdi, A. R., Fakhim, A., Shahverdi, H. R. & Minaian, S. (2007). Synthesis and effect of silver nanoparticles on the antibacterial activity of different antibiotics against ***Staphylococcus aureus*** and ***Escherichia coli.*** *Nanomedicine*.3(2), 168–171.

PUBLICATION FROM THE WORK

Pathak, M., Sharma, M., Ojha, H., Kumari, R., Sharma, N., Roy, B., Jain, G., (2016) Green synthesis, characterization and antibacterial activity of silver nanoparticles. *Green Chemistry & Technology Letters*, 2(1), 108-115.
http://dx.doi.org/10.18510/gctl.2015.1114

CONFERENCE PRESENTATIONS

Pathak*, M., Sharma, M., Kumari, R. Anamika, Raza, A.,Payal., Khare, A., Pandey, A., Majumdar, I., Rajput, M., Bhatt, D., Jain, R., Maheshwari, H., (2016). Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles. Paper presented at the **94th Foundation day Celebration** at University of Delhi. Received **Certificate of Appreciation**.

Jain, R., Pandey, A., Bhatt, D., Majumdar, I., Maheshwari, H., Rajput, M., Sharma, M., Pathak*, M., Kumari, R. (2015). *Green and Ecofriendly synthesis of silver nanoparticles.* Paper presented at the National seminar on Innovative advance research in Bio-Medical and Environmental Dynamics, Dyal Singh College, University of Delhi, 9-10 October 2015. Secured **Third** position.

Sharma, M., Pathak, M. (2015) *Ecofriendly synthesis of silver nanoparticles and their characterization.* Paper presented at the RSC Workshop Chemistry for Tomorrow's world, Department of Chemistry, University of Delhi, 2-3 December 2015.

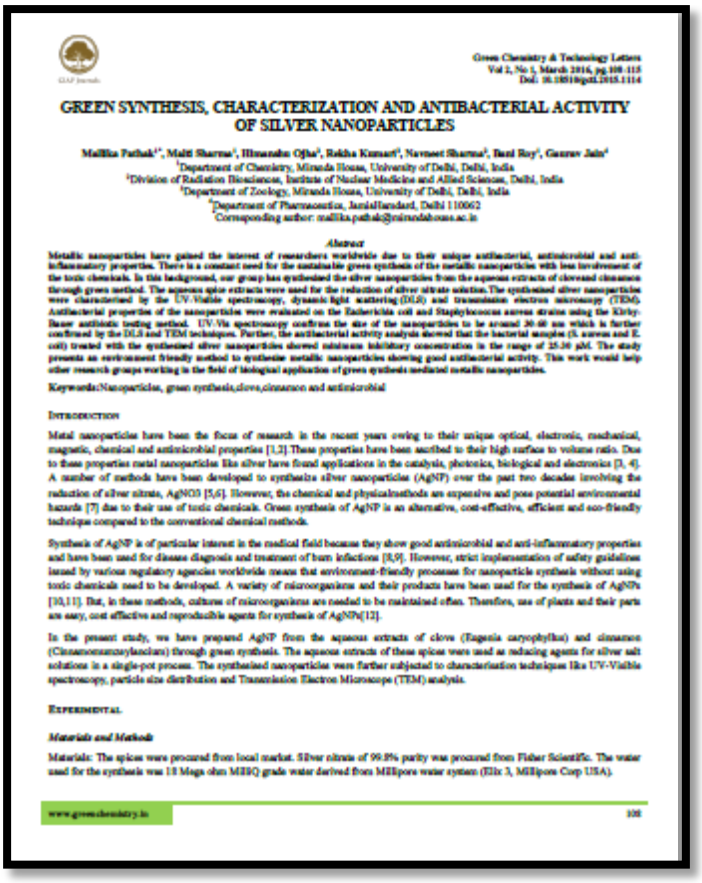
Pandey, A., Majumdar, I., Rajput, M., Bhatt, M., Jain, R., Maheshwari, H., Payal, Khare, A., Raza, A., Anamika, Kumari, R., Sharma, M., Pathak, M*. (2016). *Spices mediated green synthesis of silver nanoparticles and characterization.* Paper presented at the DU-JAIST Indo-Japan Symposium on Chemistry of Functional Molecules/Materials, Department of Chemistry, University of Delhi, 26-27 February 2016.

Sharma*, M., Pathak, M., Kumari, R., Maheshwari, H., Jain, R., Rajput, M., Pandey,A., Majumdar, I., Bhatt, D., Payal, Khare, A., Raza, A., Anamika. (2016). *Spice mediated ecofriendly synthesis of silver nanoparticles and characterization.* Paper presented at the Indo-Portugese workshop on "Emerging Trends of Nanotechnology in Chemical and Biology, 12-13 February 2016.

Anamika., Raza, A., Payal., Khare, A., Pandey, A., Majumdar, I., Rajput, M., Bhatt, D., Jain, R., Maheshwari, H., Kumari, R., Sharma, M., Pathak, M. (2016). *Spices mediated green synthesis of silver nanoparticles and their antimicrobial properties.* Paper presented at the National Conference in Chemistry Environment & Harmonious Development, Shyam Lal College, 7-8 April 2016.

Rajput, M., Jain, R., Bhatt, D., Pandey, A., Majumdar, I., Maheshwari, H., Payal., Khare, A., Raza, A., Anamika, Kumari, R., Sharma, M., Pathak, M. *Silver nanoparticles: Green synthesis and characterization.* Paper presented at the National Conference in Chemistry Environment & Harmonious Development, Shyam Lal College, 7-8 April 2016.

PICTURES RELATED TO THE PROJECT



Green Chemistry & Technology Letters
Vol 2, No 1, March 2016, pg 108-115
Doi: 10.18510/gctl.2015.1114

GREEN SYNTHESIS, CHARACTERIZATION AND ANTIBACTERIAL ACTIVITY OF SILVER NANOPARTICLES

Mallika Pathak[1*], Malti Sharma[1], Himanshu Ojha[2], Rekha Kumari[3], Navneet Sharma[2], Bani Roy[1], Gaurav Jain[4]
[1]Department of Chemistry, Miranda House, University of Delhi, Delhi, India
[2]Division of Radiation Biosciences, Institute of Nuclear Medicine and Allied Sciences, Delhi, India
[3]Department of Zoology, Miranda House, University of Delhi, Delhi, India
[4]Department of Pharmaceutics, JamiaHamdard, Delhi 110062
*Corresponding author: mallika.pathak@mirandahouse.ac.in

Abstract

Metallic nanoparticles have gained the interest of researchers worldwide due to their unique antibacterial, antimicrobial and anti-inflammatory properties. There is a constant need for the sustainable green synthesis of the metallic nanoparticles with less involvement of the toxic chemicals. In this background, our group has synthesized the silver nanoparticles from the aqueous extracts of clovesand cinnamon through green method. The aqueous spice extracts were used for the reduction of silver nitrate solution.The synthesized silver nanoparticles were characterized by the UV-Visible spectroscopy, dynamic light scattering (DLS) and transmission electron microscopy (TEM). Antibacterial properties of the nanoparticles were evaluated on the Escherichia coli and Staphylococcus aureus strains using the Kirby-Bauer antibiotic testing method. UV-Vis spectroscopy confirms the size of the nanoparticles to be around 30-60 nm which is further confirmed by the DLS and TEM techniques. Further, the antibacterial activity analysis showed that the bacterial samples (S. aureus and E. coli) treated with the synthesized silver nanoparticles showed minimum inhibitory concentration in the range of 25-30 µM. The study presents an environment friendly method to synthesize metallic nanoparticles showing good antibacterial activity. This work would help other research groups working in the field of biological application of green synthesis mediated metallic nanoparticles.

Keywords:Nanoparticles, green synthesis,clove,cinnamon and antimicrobial

Introduction

Metal nanoparticles have been the focus of research in the recent years owing to their unique optical, electronic, mechanical, magnetic, chemical and antimicrobial properties [1,2].These properties have been ascribed to their high surface to volume ratio. Due to these properties metal nanoparticles like silver have found applications in the catalysis, photonics, biological and electronics [3, 4]. A number of methods have been developed to synthesize silver nanoparticles (AgNP) over the past two decades involving the reduction of silver nitrate, AgNO3 [5,6]. However, the chemical and physicalmethods are expensive and pose potential environmental hazards [7] due to their use of toxic chemicals. Green synthesis of AgNP is an alternative, cost-effective, efficient and eco-friendly technique compared to the conventional chemical methods.

Synthesis of AgNP is of particular interest in the medical field because they show good antimicrobial and anti-inflammatory properties and have been used for disease diagnosis and treatment of burn infections [8,9]. However, strict implementation of safety guidelines issued by various regulatory agencies worldwide means that environment-friendly processes for nanoparticle synthesis without using toxic chemicals need to be developed. A variety of microorganisms and their products have been used for the synthesis of AgNPs [10,11]. But, in these methods, cultures of microorganisms are needed to be maintained often. Therefore, use of plants and their parts are easy, cost effective and reproducible agents for synthesis of AgNPs[12].

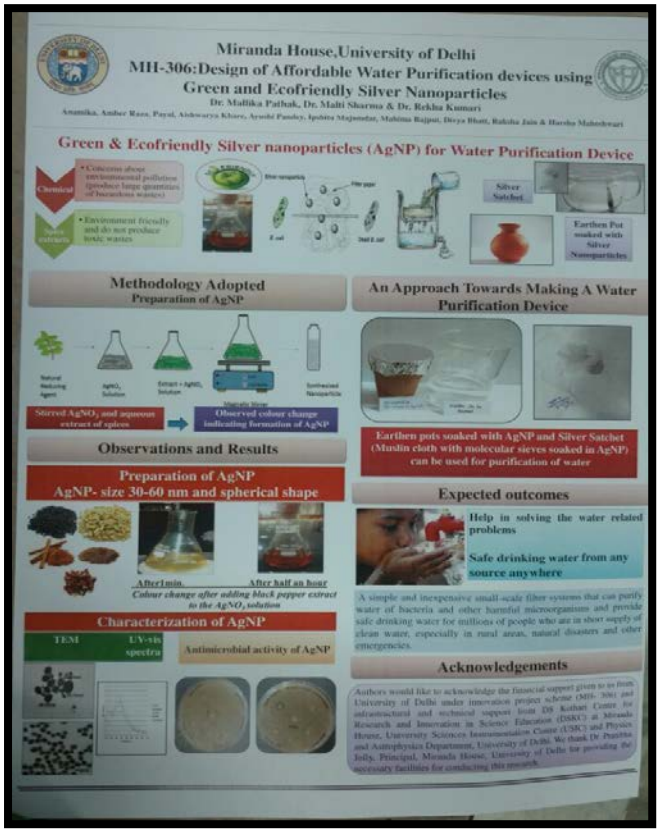
In the present study, we have prepared AgNP from the aqueous extracts of clove (Eugenia caryophyllus) and cinnamon (Cinnamomumzeylanicum) through green synthesis. The aqueous extracts of these spices were used as reducing agents for silver salt solutions in a single-pot process. The synthesized nanoparticles were further subjected to characterisation techniques like UV-Visible spectroscopy, particle size distribution and Transmission Electron Microscope (TEM) analysis.

Experimental

Materials and Methods

Materials: The spices were procured from local market. Silver nitrate of 99.8% purity was procured from Fisher Scientific. The water used for the synthesis was 18 Mega ohm MilliQ grade water derived from Millipore water system (Elix 3, Millipore Corp USA).

www.greenchemistry.in 108



Miranda House,University of Delhi

MH-306:Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles

Dr. Mallika Pathak, Dr. Malti Sharma & Dr. Rekha Kumari

Anamika, Amber Raza, Payal, Aishwarya Khare, Ayushi Pandey, Ipshita Majumdar, Mahima Rajput, Divya Bhatt, Raksha Jain & Harsha Maheshwari

Green & Ecofriendly Silver nanoparticles (AgNP) for Water Purification Device

Chemical: • Concerns about environmental pollution (produce large quantities of hazardous wastes)

Green methods: • Environment friendly and do not produce toxic wastes

Silver Satchet

Earthen Pot soaked with Silver Nanoparticles

Methodology Adopted

Preparation of AgNP

Stirred $AgNO_3$ and aqueous extract of spices

Observed colour change indicating formation of AgNP

Observations and Results

Preparation of AgNP

AgNP- size 30-60 nm and spherical shape

After1min. After half an hour

Colour change after adding black pepper extract to the $AgNO_3$ solution

Characterization of AgNP

TEM UV-vis spectra

Antimicrobial activity of AgNP

An Approach Towards Making A Water Purification Device

Earthen pots soaked with AgNP and Silver Satchet (Muslin cloth with molecular sieves soaked in AgNP) can be used for purification of water

Expected outcomes

Help in solving the water related problems

Safe drinking water from any source anywhere

A simple and inexpensive small-scale filter systems that can purify water of bacteria and other harmful microorganisms and provide safe drinking water for millions of people who are in short supply of clean water, especially in rural areas, natural disasters and other emergencies.

Acknowledgements

Authors would like to acknowledge the financial support given to us from University of Delhi under innovation project scheme (MH- 306) and infrastructural and technical support from DU Kothari Centre for Research and Innovation in Science Education (DSKC) at Miranda House, University Sciences Instrumentation Centre (USIC) and Physics and Astrophysics Department, University of Delhi. We thank Dr Pramita Jolly, Principal, Miranda House, University of Delhi for providing the necessary facilities for conducting this research.

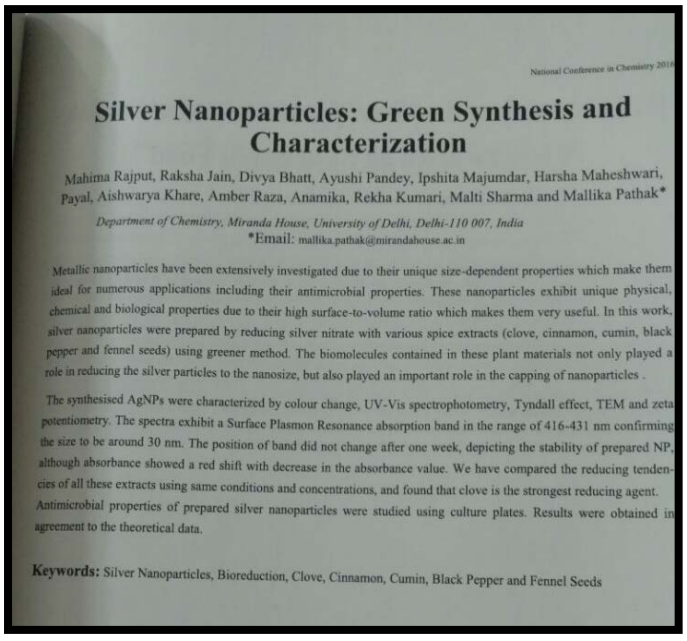
University of Delhi

94th Foundation Day Celebration

Display of Select Innovation Projects (2015-

An Initiative of University of Delhi

Name of the college	Project Code	Project Title
Acharya Narendra Dev College	ANDC 301	Development of low-cost, robust, portable water purifier prototy physical, chemical and biological filtration for field water disinfect potable water generation in natural calamity affected zones wit conditions
Bhaskaracharya College of Applied Sciences	BCAS 305	To explore the potential of biosimilars as cost-effective therapeutic produc
Bhaskaracharya College of Applied Sciences	BCAS 308	Exploring the Involvement of Mechanotransduction Network in Inter-leuk Differences through Ayurgenomics Approach
Cluster Innovation Centre	CIC 307	Developing an affordable three-dimensional Bio printer
Daulat Ram College	DR 301	Zebra Fish as a Biosensor for assessing Yamuna River Water Quality in Delhi Region
Gargi College	GC 302	A Green and Sustainable Chemistry Laboratory....A Distant Dream.... Or a Reali
Hansraj College	HRC 310	Emergency Management Solutions: Design of Solar based Eco-Friendly, Efficien and Portable Lighting/Pmesic, Water Conditioning and Therma-electric Solutions
Kalindi College	KC 304	Conversion of Wind Energy to Electrical Energy at Delhi Metro Stations using light rotor turbines
Kirori Mal College	KMC 303	KMC MARS ROVER helping astronauts in exploration of the Red Planet Mars!
Lakshmibai College	LB 301	Women Empowerment Through Low Cost Technology
Miranda House	MH 301	Climate Change, Water Security and Livelihood Resilience: Role of Traditional Knowledge and Modern technologies in Rajasthan, India
Miranda House	MH 306	Design of Affordable Water Purification devices using Green and Ecofriendly Silver Nanoparticles
Ramanujan College	RNC 304	From Tradition to Modernity: Narrating Folklore in Madhubani Paintings-A Film
Ramjas College	RC 301	Econophysics Approach to Indian Stock Market: Correlation, Networks, and Multifractal Analysis.
Shaheed Rajguru College of Applied Sciences	SRCAS 316	Low cost eco-friendly Solar Inverter- A standalone solar power system for households
SGTB Khalsa College	SGTB 301	Detection of Fingerprints on Designed Crime Scenes
Shivaji College	SHC 309	Real Time Android Application for Travel convenience
Sri Aurobindo College	SAC 301	WASTE TO WEALTH: Water Hyacinth—A New Green Fuel Source
Sri Venkateshwara College	SVC 301	Comparative genomics of Dengue virus to explore potential candidates for novel drug targets.
St. Stephens College	SSC 302	Smart medicines: Investigation of Physico-chemical and Nanoscale properties of materials and Study of Mathematics of dilution with respect to Homeopathy



National Conference in Chemistry 2018

Silver Nanoparticles: Green Synthesis and Characterization

Mahima Rajput, Raksha Jain, Divya Bhatt, Ayushi Pandey, Ipshita Majumdar, Harsha Maheshwari, Payal, Aishwarya Khare, Amber Raza, Anamika, Rekha Kumari, Malti Sharma and Mallika Pathak*

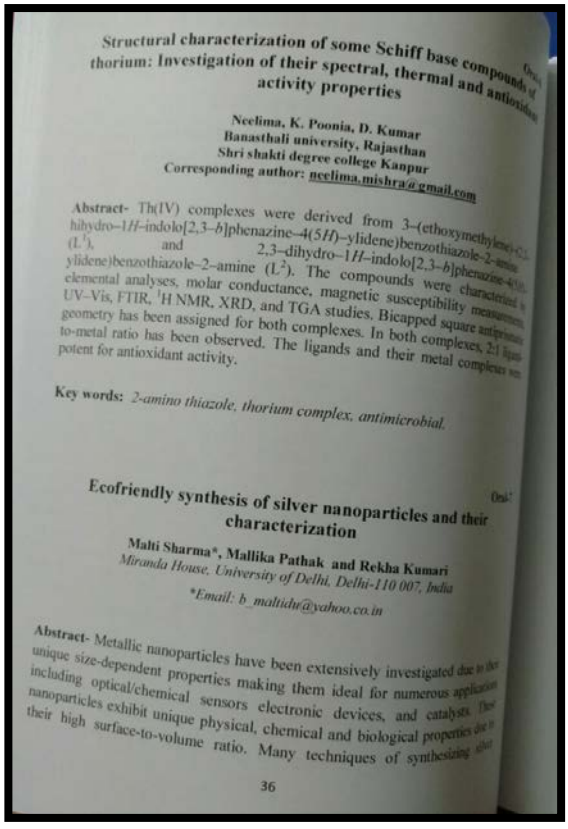
Department of Chemistry, Miranda House, University of Delhi, Delhi-110 007, India

*Email: mallika.pathak@mirandahouse.ac.in

Metallic nanoparticles have been extensively investigated due to their unique size-dependent properties which make them ideal for numerous applications including their antimicrobial properties. These nanoparticles exhibit unique physical, chemical and biological properties due to their high surface-to-volume ratio which makes them very useful. In this work, silver nanoparticles were prepared by reducing silver nitrate with various spice extracts (clove, cinnamon, cumin, black pepper and fennel seeds) using greener method. The biomolecules contained in these plant materials not only played a role in reducing the silver particles to the nanosize, but also played an important role in the capping of nanoparticles .

The synthesised AgNPs were characterized by colour change, UV-Vis spectrophotometry, Tyndall effect, TEM and zeta potentiometry. The spectra exhibit a Surface Plasmon Resonance absorption band in the range of 416-431 nm confirming the size to be around 30 nm. The position of band did not change after one week, depicting the stability of prepared NP, although absorbance showed a red shift with decrease in the absorbance value. We have compared the reducing tendencies of all these extracts using same conditions and concentrations, and found that clove is the strongest reducing agent. Antimicrobial properties of prepared silver nanoparticles were studied using culture plates. Results were obtained in agreement to the theoretical data.

Keywords: Silver Nanoparticles, Bioreduction, Clove, Cinnamon, Cumin, Black Pepper and Fennel Seeds



Structural characterization of some Schiff base compounds of thorium: Investigation of their spectral, thermal and antioxidant activity properties

Neelima, K. Poonia, D. Kumar

Banasthali university, Rajasthan

Shri shakti degree college Kanpur

Corresponding author: neelima.mishra@gmail.com

Abstract- Th(IV) complexes were derived from 3-(ethoxymethylene)-2,3-dihydro-1*H*-indolo[2,3-*b*]phenazine-4(5*H*)-ylidene)benzothiazole-2-amine (L^1), and 2,3-dihydro-1*H*-indolo[2,3-*b*]phenazine-4(5H)-ylidene)benzothiazole-2-amine (L^2). The compounds were characterized by elemental analyses, molar conductance, magnetic susceptibility measurements, UV–Vis, FTIR, ^{1}H NMR, XRD, and TGA studies. Bicapped square antiprismatic geometry has been assigned for both complexes. In both complexes, 2:1 ligand-to-metal ratio has been observed. The ligands and their metal complexes were potent for antioxidant activity.

Key words: *2-amino thiazole, thorium complex, antimicrobial.*

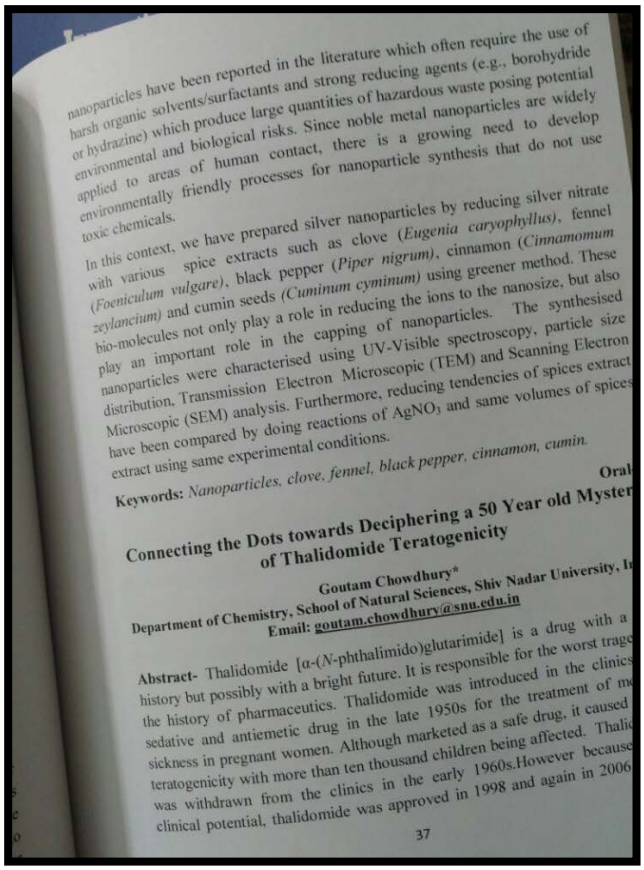
Ecofriendly synthesis of silver nanoparticles and their characterization

Malti Sharma*, Mallika Pathak and Rekha Kumari

Miranda House, University of Delhi, Delhi-110 007, India

**Email: b_maltidr@yahoo.co.in*

Abstract- Metallic nanoparticles have been extensively investigated due to their unique size-dependent properties making them ideal for numerous applications including optical/chemical sensors electronic devices, and catalysts. These nanoparticles exhibit unique physical, chemical and biological properties due to their high surface-to-volume ratio. Many techniques of synthesizing silver



nanoparticles have been reported in the literature which often require the use of harsh organic solvents/surfactants and strong reducing agents (e.g., borohydride or hydrazine) which produce large quantities of hazardous waste posing potential environmental and biological risks. Since noble metal nanoparticles are widely applied to areas of human contact, there is a growing need to develop environmentally friendly processes for nanoparticle synthesis that do not use toxic chemicals.

In this context, we have prepared silver nanoparticles by reducing silver nitrate with various spice extracts such as clove (*Eugenia caryophyllus*), fennel (*Foeniculum vulgare*), black pepper (*Piper nigrum*), cinnamon (*Cinnamomum zeylancium*) and cumin seeds (*Cuminum cyminum*) using greener method. These bio-molecules not only play a role in reducing the ions to the nanosize, but also play an important role in the capping of nanoparticles. The synthesised nanoparticles were characterised using UV-Visible spectroscopy, particle size distribution, Transmission Electron Microscopic (TEM) and Scanning Electron Microscopic (SEM) analysis. Furthermore, reducing tendencies of spices extract have been compared by doing reactions of $AgNO_3$ and same volumes of spices extract using same experimental conditions.

Keywords: *Nanoparticles, clove, fennel, black pepper, cinnamon, cumin.*

Oral

Connecting the Dots towards Deciphering a 50 Year old Myster of Thalidomide Teratogenicity

Goutam Chowdhury*

Department of Chemistry, School of Natural Sciences, Shiv Nadar University, I

Email: goutam.chowdhury@snu.edu.in

Abstract- Thalidomide [α-(*N*-phthalimido)glutarimide] is a drug with a history but possibly with a bright future. It is responsible for the worst tragedy the history of pharmaceutics. Thalidomide was introduced in the clinics sedative and antiemetic drug in the late 1950s for the treatment of m sickness in pregnant women. Although marketed as a safe drug, it caused teratogenicity with more than ten thousand children being affected. Thalid was withdrawn from the clinics in the early 1960s.However because clinical potential, thalidomide was approved in 1998 and again in 2006

GREEN AND ECOFRIENDLY SYNTHESIS OF SILVER NANOPARTICLES.

Raksha Jain, Ayushi Pandey, Divya Bhatt, IpshitaMajumdar, HarshaMaheshwari, Mahima Rajput, Malti Sharma, Mallika Pathak and RekhaKumari

Department of Chemistry, Miranda House, University of Delhi, Delhi-110 007, INDIA

Email : mallika.pathak@mirandahouse.ac.in

Abstract

In this work, the synthesis of stable silver nanoparticles by the bioreduction method was investigated. Aqueous extracts of the spices such as clove, cinnamon, cumin, black pepper and fennel seeds were used as reducing and stabilizing agents. The distinctive properties of silver nanoparticles make them ideal for numerous applications [1,2]. The synthesised AgNPs were characterized by colour change, UV-Vis spectrophotometry and Tyndall effect and analyzed by SEM and zeta potentiometry. The spectra exhibita Surface Plasmon Resonance absorption band in the range of 416-431nm confirming the size to be around 30 nm[3]. The position of banddid not change after one week, depicting the stability of prepared Nps, although absorbance showed a red shift with decrease in the absorbance value. We have compared the reducing tendencies of all these extracts using same conditions and concentrationsand found that clove is the strongest reducing agent.

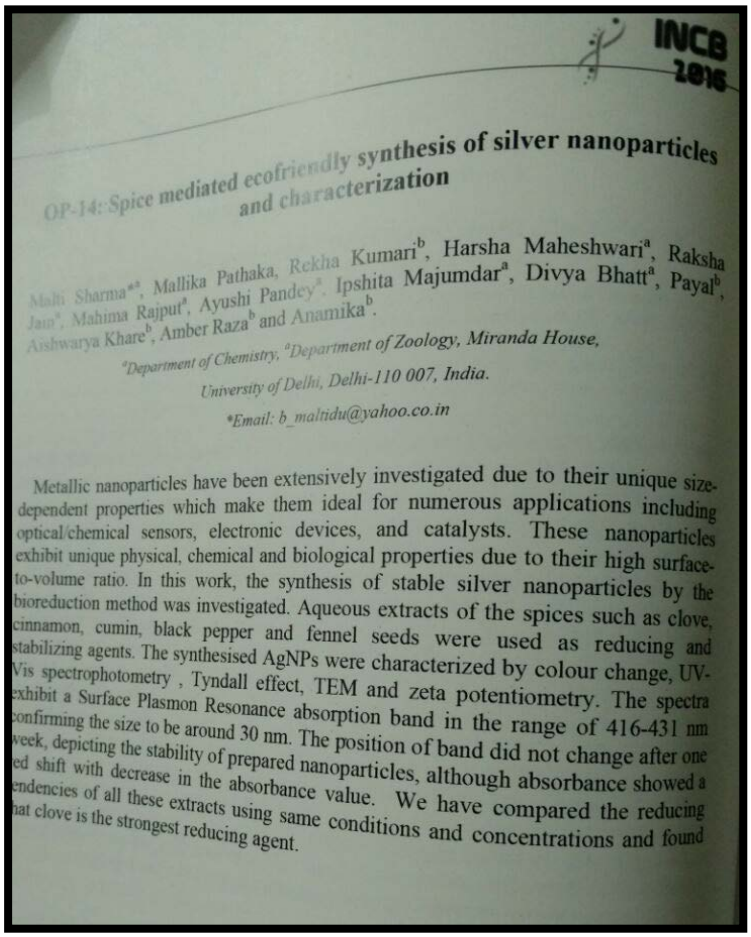
References:

[1]. Lin J, Chen R, Feng S, Pan J, Li Y, Chen G et al., **2011**,*Nanotechnology, Biology and Medicine. 7(5), 655-663.*

[2]. Kim J S, Kuk E, Yu K N, Kim J H, Park S J, Lee H J et al., **2007**,*Nanotechnology, Biology and Medicine, 3(1), 95-101*

[3]. Zhou G, Wang W, **2012**, *Orient. J Chem., 28(2), 651-655.*

Keywords: Silver nanoparticles(AgNps), bioreduction, clove, cinnamon, cumin, black pepper and fennel seeds



INCB 2016

OP-14: Spice mediated ecofriendly synthesis of silver nanoparticles and characterization

Malti Sharma[a*], Mallika Pathaka, Rekha Kumari[b], Harsha Maheshwari[a], Raksha Jain[a], Mahima Rajput[a], Ayushi Pandey[a], Ipshita Majumdar[a], Divya Bhatt[a], Payal[b], Aishwarya Khare[b], Amber Raza[b] and Anamika[b].

[a]*Department of Chemistry,* [b]*Department of Zoology, Miranda House, University of Delhi, Delhi-110 007, India.*

**Email: b_maltidu@yahoo.co.in*

Metallic nanoparticles have been extensively investigated due to their unique size-dependent properties which make them ideal for numerous applications including optical/chemical sensors, electronic devices, and catalysts. These nanoparticles exhibit unique physical, chemical and biological properties due to their high surface-to-volume ratio. In this work, the synthesis of stable silver nanoparticles by the bioreduction method was investigated. Aqueous extracts of the spices such as clove, cinnamon, cumin, black pepper and fennel seeds were used as reducing and stabilizing agents. The synthesised AgNPs were characterized by colour change, UV-Vis spectrophotometry , Tyndall effect, TEM and zeta potentiometry. The spectra exhibit a Surface Plasmon Resonance absorption band in the range of 416-431 nm confirming the size to be around 30 nm. The position of band did not change after one week, depicting the stability of prepared nanoparticles, although absorbance showed a ed shift with decrease in the absorbance value. We have compared the reducing endencies of all these extracts using same conditions and concentrations and found hat clove is the strongest reducing agent.